

Impacts of land cover change on climate trend in Padang Indonesia

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Abstract The purpose of this study was to analyze the trend of climate change through changes in the elements of Green House Gases (GHGs), includes the trend of CO₂, N₂O, and CH₄. The change of the extreme rainfall and temperature indices due to land cover change into developed area in Padang. Identification and analysis trends of climate change and extreme climatic events were analyzed by using RclimDex the Expert Team for Climate Change Detection and Indices (ETCCDMI) technique. Where as the analysis and interpretation of land cover changes into developed area used Landsat TM 5 and Landsat 1985 7 ETM + of 2011 by ERDAS 9.2 GIS with the supervised classification method and GIS Matrix. The results of the study provide informations of land cover changes into developed area at forest land (11,758.9 ha), shrub (3,337.3 ha), rice fields (5,977.1 ha), and garden (5,872.4 ha). It has an implication on increasing of the elements of GHGs concentration such as CO₂ (14,1 ppm), N₂O (5,4 ppb) and CH₄ (24,8 ppb). This condition lead to an extreme temperature and presipitation indexs trends in Padang.

Keywords: Climate Change; Green House Gases; Land Cover Changes

Abstrak Tujuan penelitian ini adalah menganalisis trend perubahan iklim melalui perubahan unsur-unsur Gas Rumah kaca (GRK) yang meliputi trend CO₂, N₂O, dan CH₄, serta indeks temperatur dan curah hujan ekstrim akibat perubahan tutupan lahan menjadi lahan terbangun di Kota Padang. Identifikasi dan analisis trend perubahan iklim dan kejadian-kejadian iklim ekstrim di analisis dengan menggunakan metode RclimDex dengan teknik Expert Team for Climate Change Detection and Indices (ETCCDMI), sedangkan analisis perubahan tutupan lahan menjadi lahan terbangun dilakukan dengan interpretasi Citra Landsat TM+5 tahun 1985 dan Citra Landsat ETM+7 tahun 2011 dengan GIS ERDAS 9.2 dengan metode supervised classification dan GIS Matrix. Hasil penelitian memberikan informasi perubahan tutupan lahan menjadi lahan terbangun yang cukup ekstrim terjadi pada lahan hutan (11.758,9 ha), semak (3.337,3 ha), sawah (5.977,1 ha), dan kebun (5.872,4 ha). Kondisi ini mengakibatkan trend yang meningkat dari CO₂ sebesar 14,1 ppm, N₂O meningkat sebesar 5,4 ppb, dan CH₄ meningkat sebesar 24,8 ppb. Hal ini secara langsung mengakibatkan terjadinya trend indeks temperatur ekstrim dan curah hujan ekstrim di Kota Padang.

Kata kunci: Perubahan Iklim, Gas Rumah Kaca, Perubahan Tutupan Lahan

I. Introduction

Land cover change is an urban development phenomenon that is difficult to solve. This is due to the urban development which directly change natural land functions. In line with the urban development caused the pressure on forest land conversion into developed area. The land cover changes will lead to the increasing of CO₂ concentration in the atmosphere. The changes in agricultural and farm land into developed area will produce an increasing trend of N₂O and NH₄. That would affect the changes of climatic conditions in the region directly [Hermon, 2012a]. CO₂, N₂O, and NH₄ are included in green house gas (GHG) which naturally can adsorb the heat radiation in the atmosphere. The change in GHGs concentration will impact unstable

climatic conditions both on extreme temperature and rainfall. GHG emissions have been increasing due to the increased of fossil fuels (FF) consumption since the industrial revolution in the mid 1980s. In the last decade, CH₄ emissions have declined by 22 million tons/year from 37 million tons/year in the previous decade and N₂O emissions also decreased slightly from 3,9 to 3.8 million tons/year. The CO₂ emissions increased by more than double from 1.400 million tons/year to 2.900 million tones/year. It had an implication on temperature rising by 0.50 C° compare to pre industrial. In the long term, earth temperature will tend to be higher than the current temperature [IPCC, 2001; Hermon, 2010].

Padang is the capital city of West Sumatra Province. that has a flat to hilly relief in general, primary forest located on the eastern and southern city. It continues over the time. Land cover change into developed area covered 3,044.20 ha in 1980 and increased to 8,288.28

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ha in 1995, 12,444.21 ha in 2005 compared to 69,496 ha of Padang area [BPS Padang, 1981; BPS Padang, 1995; BPS Padang, 2006]. Land cover changes into developed area generally occur in the Lubuk Kilangan, Bungus Teluk Kabung, Koto Tangah, and Padang Selatan district. Those are belong to the hills with forest vegetation [Hermon, 2009; Hermon, 2012a; Hermon, 2012b]. The objectives of this study was is to analyze the climate trend caused by land cover changes in Padang.

2. The Methods

According to Zain [2002], Hermon [2009], and Hermon [2012b], the dynamics of land cover changes into developed area by interpretation of Landsat TM + 5 (1985) and Landsat ETM + 7 (2011) using ERDAS 9.2 as analysis tools. The analysis of land cover classification used supervised classification techniques on each images. This formulated six patterns of landcover, ie: (1) forest, (2) garden, (3) shrub, (4) open land, (5) paddy field, and (6) developed area. The analysis of area change (ha) for each land cover in 1985 and 2011 used ERDAS 8.6 and tools Interpreter (GIS Analysis-Matrix). Rclimindex with Expert Team for Climate Change Detection and Indices (ETCCDMI) technique had used for climate change and climatic extreme events.

3. Result and Discussion

The result of Landsat 5 TM + (1985) and Landsat ETM + 7 (2011) shows that land cover changes into developed area had an increasing trend. The Increasing trend of land cover change into developed land generally occurs in the eastern part of Padang. The area was converted from forest, gardens, shrubs, and rice paddies into developed area (Table 1).

Forest land, shrub, paddy field and mixed garden had changed into developed area. The change of forest land into developed area during 1985 – 2011 reached 11.758,9 ha while paddy field changes into-developed land area as much as 5.977,1 ha. The changes of garden into developed area was 5.872,4 ha and shrub land

changes is 3.337,3 ha (Figure 1).

The land cover changes leads to increading trend of GHG concentration for CO₂, N₂O, and NH₄. It will impact the change in temperature and rainfall patterns in Padang. The concentrate of CO₂, N₂O, and NH₄ from 1985 to 2011 showed an increasing trend. The concentrate of CO₂ increased by 14.1 ppm, N₂O increased by 5.4 ppb, and CH₄ increased by 24.8 ppb. Nahas and Setiawan [2009] explained that the increase of CO₂ concentrate in the air causes the increase of radiative forcing. The avarage of CO₂ radiative forcing was $0.04 \pm 1.634 \text{ Wm}^{-2}$, radiative forcing of CH₄ was $0.509 \pm 0.003 \text{ Wm}^{-2}$, and radiative forcing of N₂O was $0.168 \pm 0.005 \text{ Wm}^{-2}$.

Table 1. The Land Cover Area in 1985 and 2011

No	Type of Land Cover	Area (ha)	
		1985	2011
1	Developed Area	3,157.0	28,573.2
2	Open Land	513.4	1,709.9
3	Shrub	4,901.6	1,917.5
4	Mixed Garden	13,767.2	7,539.7
5	Forest	40,879.5	29,375.7
6	Paddy Field	5,897.3	1,997.5
7	River and Sea	380.0	380.0
Total		69,496.0	69,496.0

Source: Result of GIS Matrix Analysis of Landsat TM+5 (1985) and ETM+7 (2011) using ERDAS 9.2 (2013)

An increase of CO₂ concentration in Padang was generated due to conversion of large area of forest into developed area. This conditions also supported by shrub and garden which converted into developed area due to the urgent needs of community settlements and public facilities. Carbon stock from forest land, shrub

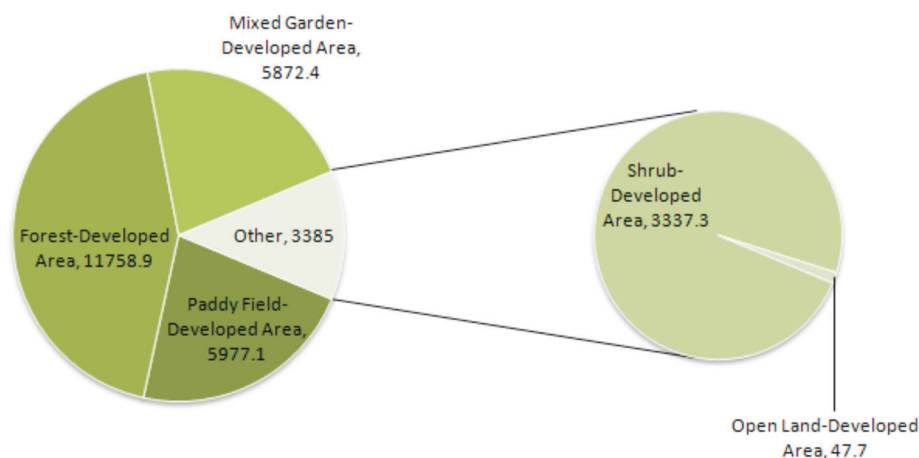


Figure 1. Land Cover Change into Developed Area (ha) in Padang from 1985 – 2011

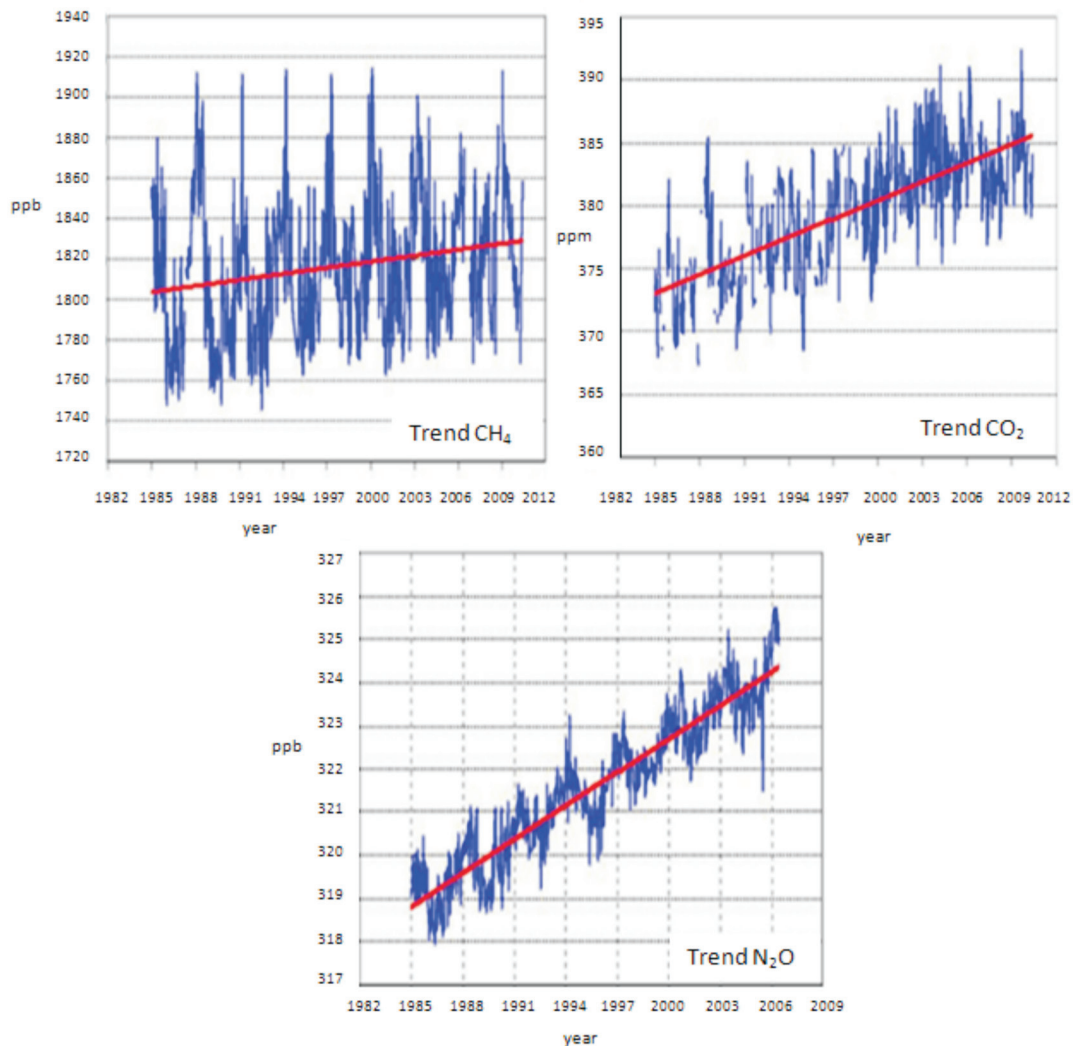


Figure 2. Trend of GHG Concentration Changes in Padang

and garden have removed and emitted as CO₂. The increasing trend of N₂O and NH₄ concentration due to paddy field, fish pond and husbandry farms converted into developed area (Figure 2).

The increasing trend of GHG concentration had a direct effects on the temperature and the extreme rainfall index in Padang. Trend of extreme temperature indices (TX10p) declined followed by incline of TX90p trend. This condition will make high temperature during day and night (Figure 3).

This is one of indicator that Padang already experiencing global warming. According to the IPCC [2001] that global warming is an indication of climate change has been caused by increasing greenhouse gases in the atmosphere.

The Trend of extreme rainfall occurred in Padang was characterized by an increasing of Rx5day compare to Rx1day. It has implication on high rainfall intensity in a relatively short time. The dominant developed area will have an accumulation of surface run off. The high volume of surface-run off will lead to flooding event,

flash flooding and landslides [Hermon, 2009; Hermon, 2012]. The high rainfall intensity in relatively short time will caused the declining CWD trend and inclining CDD trend. These conditions will lead unstable hydrological phase in the region.

4. Conclusion

Land cover changes into developed area land especially in forests, gardens and shrubs lead into the increasing of GHG concentrations. The increasing of GHG concentration will have direct effect on global warming and climate change. It had been marked that higher temperatures during the day and night and trends of extreme rainfall where high rainfall intensity in relatively short time.

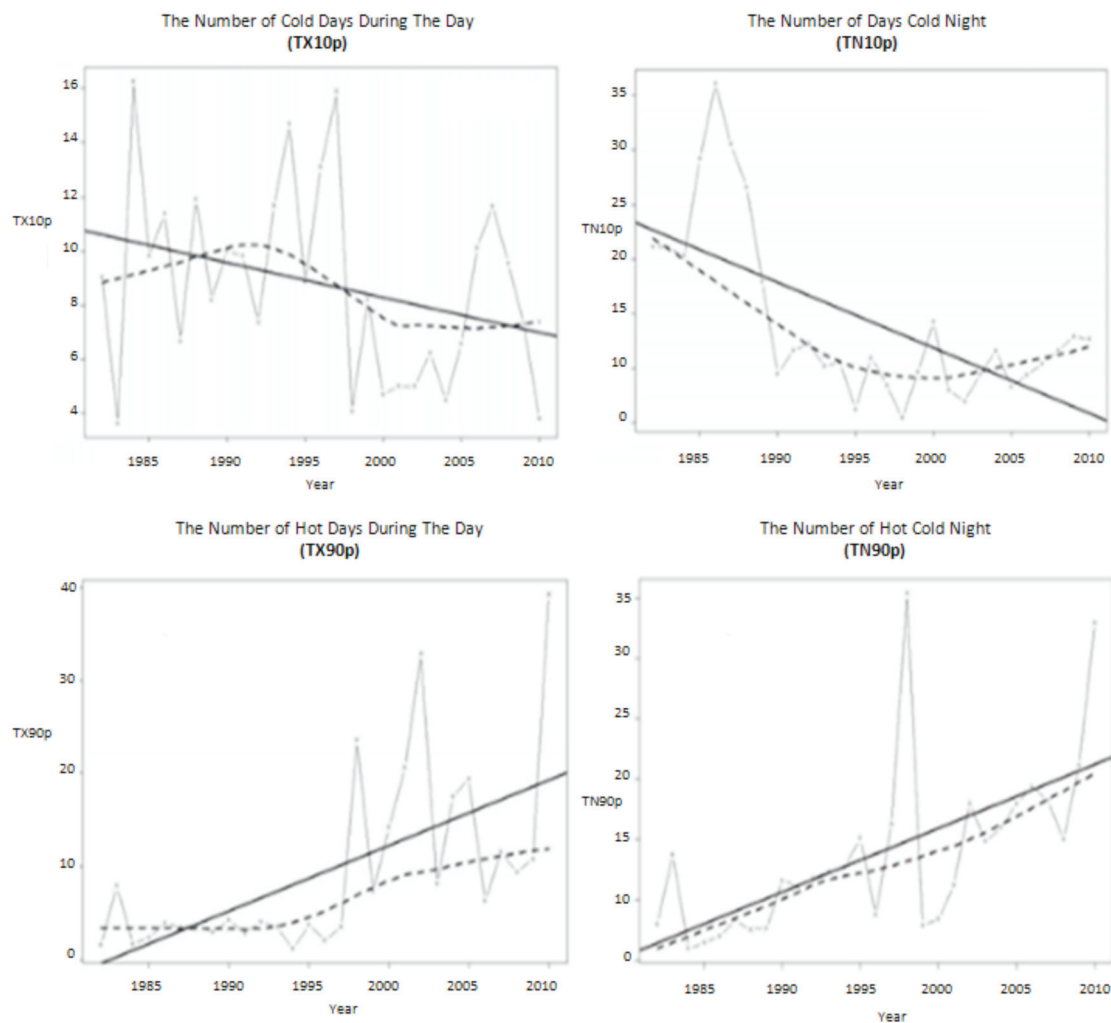


Figure 3. Trend of Extreme Rainfall Index in Padang

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